Georgia Institute of Technology

Linear Circuits

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An introduction to linear electric circuit elements and a study of circuits containing such devices.

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Voltage

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- *Modify voltage values to reflect voltage references*
- *Describe how a chemical battery works*
- *Identify if a battery is charging or discharging*

Previous Class

- Charge and its interactions via electric fields
- Current as the flow of charge

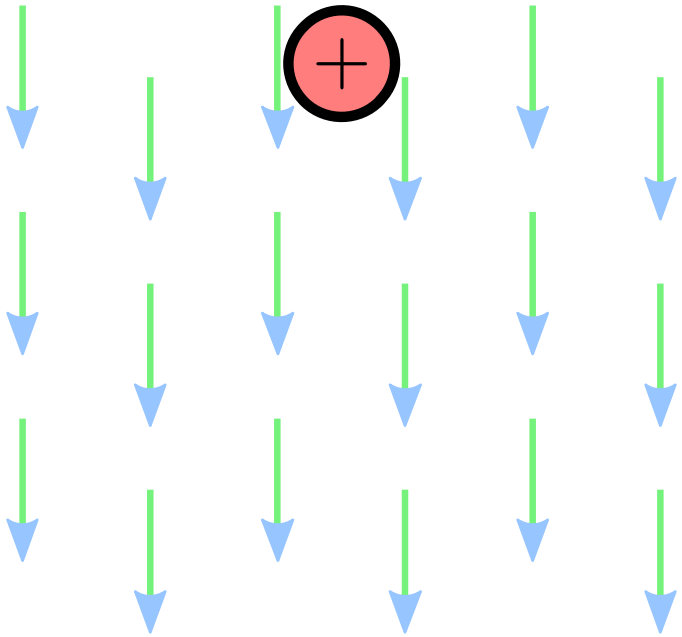
Module 1: Background

- Charge
- Current
- Voltage
- Power
- Energy
- Circuit Introduction

Lesson Objectives

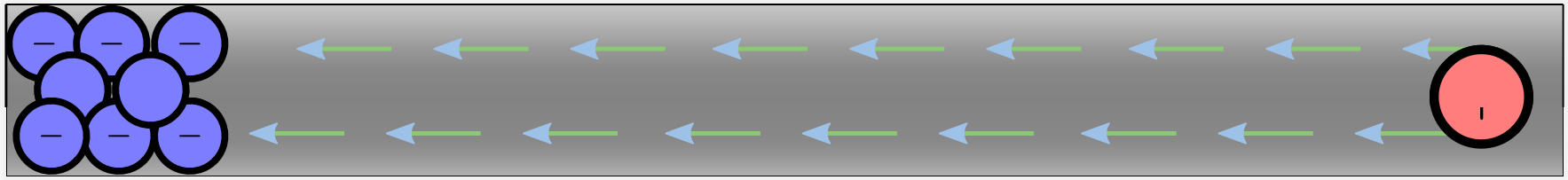
- Calculate voltage from the energy gained/consumed as a charge moves through an electric field
- Correctly specify voltages as references change
- Describe the operation of a chemical battery
- Identify if a battery is charging or discharging based on the voltage reference and current flow

Voltage

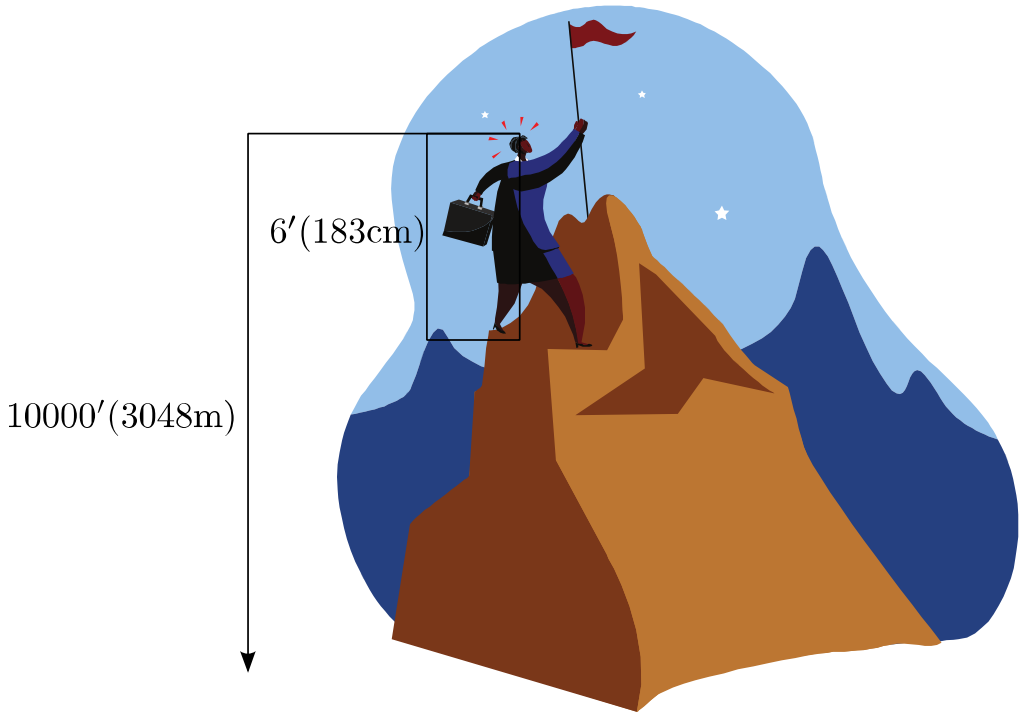


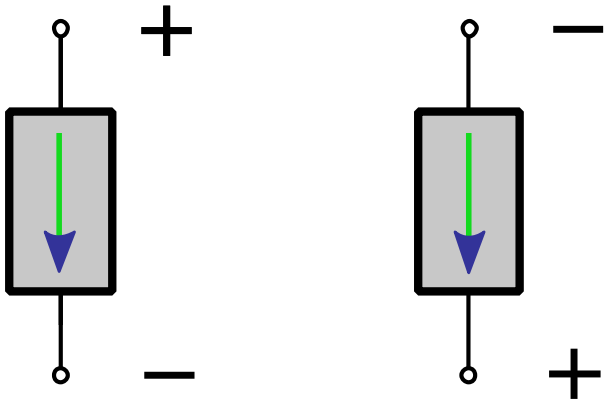
Voltage	
Units	volt $(\mathrm{V}=\frac{\mathrm{J}}{\mathrm{C}})$
Variable	v

Origin of Voltage

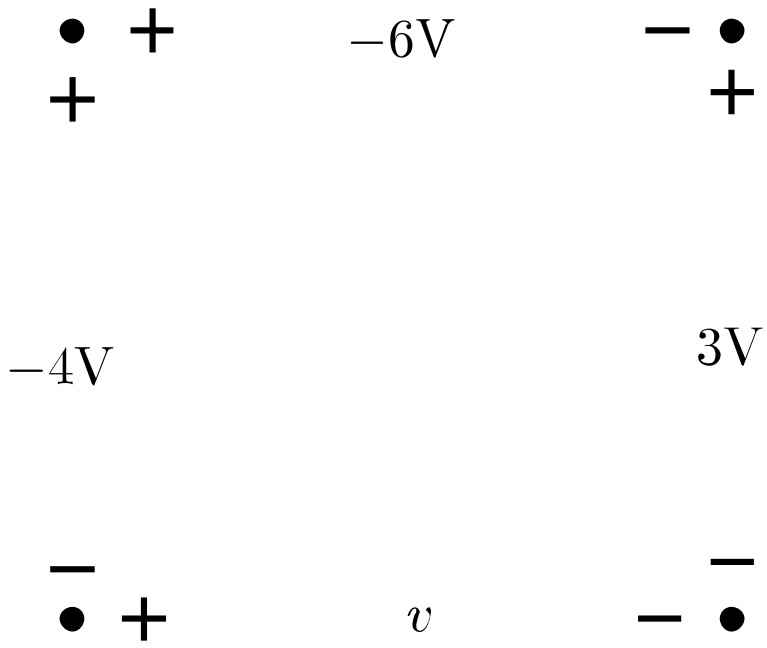


Voltage Reference

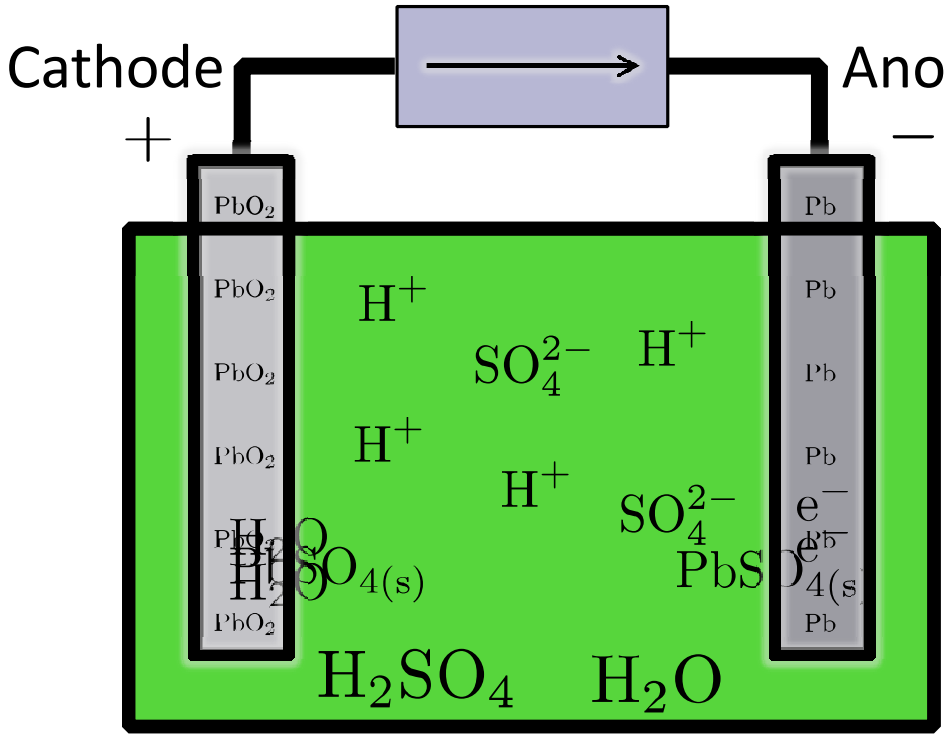




Example: Finding Voltages



Lead-Acid Batteries - Discharging



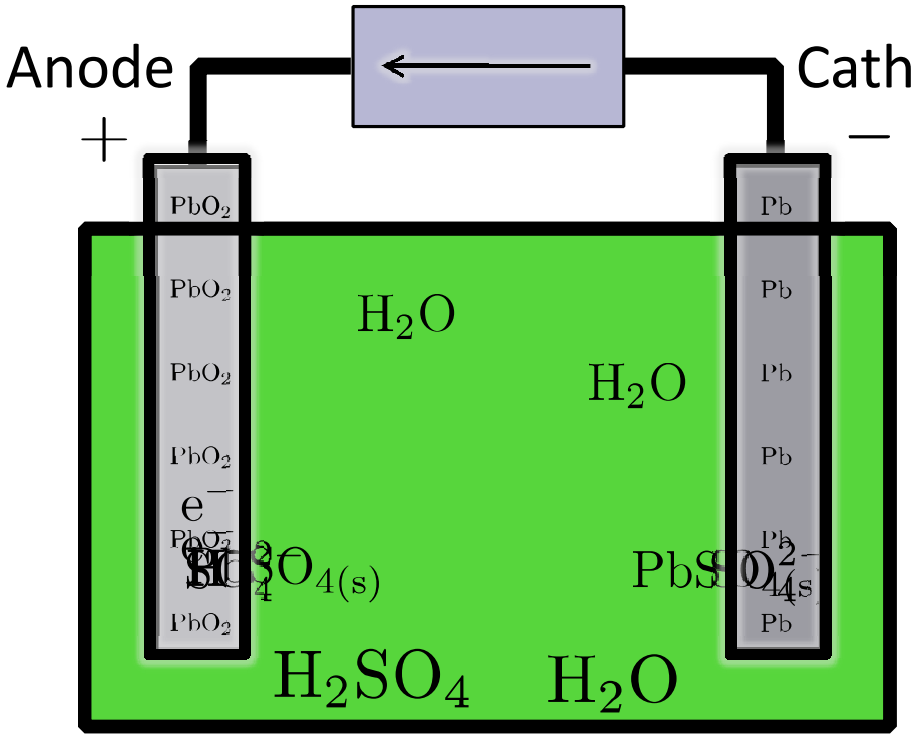
Cathode: Reduction reaction

$$PbO_{2(s)} + SO_4^{-2}{}_{(aq)} + 4H^+_{(aq)} + 2e^- \rightarrow PbSO_{4(s)} + 2H_2O_{(l)}$$

Anode: Oxidation reaction

$$Pb_{(s)} + SO_4^{-2}{}_{(aq)} \rightarrow PbSO_{4(s)} + 2e^-$$

Lead-Acid Batteries - Charging



Anode: Oxidation reaction

$$PbSO_{4(s)} + 2H_2O_{(l)} \rightarrow PbO_{2(s)} + 4H^+_{(aq)} + SO^{2-}_{4\ (aq)} + 2e^-$$

Cathode: Reduction reaction

$$PbSO_{4(s)} + 2e^- \rightarrow Pb_{(s)} + SO^{2-}_{4\ (aq)}$$

Summary

- Charge crates electric fields
- Voltage is energy gained/released as charges move through an electric field
- Described how voltage originates from differences in charge density
- Case study: how lead-acid batteries work

Next Class

- Define electrical power and energy
- See how voltage and current relate to power
- First circuit analysis